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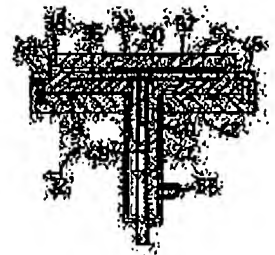
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(21)Application number : **60-120199**(71)Applicant : **DAIDO STEEL CO LTD**(22)Date of filing : **03.06.1985**(72)Inventor : **YAMADA HIROYUKI****(4) SPUTTERING DEVICE****(7)Abstract:**

**URPOSE:** To cool effectively a target and to enable the impression of high voltage and to attain the speed up of a sputtering by bringing a cooling fluid into contact directly with the surface of a side opposite to a sputtering surface and cooling the target of a sputtering device.

**ONSTITUTION:** In the sputtering device wherein a substance constituting a target 34 is sputtered by colliding violently a high-energy ion against the sputtering surface 62 of the target 34, a target holding device 32 is constituted by brazing the outside periphery part of an underside of the above-mentioned target 34 consisting of a fine material to the ring-like projection 38 of a fitting member 36 with a brazer such as silver and furthermore fixing the fitting member 36 to a holding plate 42 with the bolts 46. In the above-mentioned device 32, cooling water is fed to the inside of a space 54 between the target 34 and the fitting member 36 via a pipe 48 inserted to the inside of a cylinder 44 which is fixed to a base plate 40 of the holding plate 42 and the target 34 is directly cooled from the surface of the side opposite to the sputtering surface

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10 (54) Title of Invention: Sputtering Apparatus

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16  
17  
18 Specification

19 1. Title of the Invention

20 Sputtering Apparatus

21  
22 2. Claims

23 (Omitted).

24  
25 3. Detailed Explanation of the Invention

26 Field of the Invention

27 The present invention relates to a sputtering apparatus for forming a film on a  
28 substrate, etc. by sputtering a target, more specifically to a technology to more efficiently  
29 cool the target.

30 Conventional Art

31 A sputtering apparatus is known as one of the apparatuses to form a magnetic film  
32 on a surface of a substrate. The sputtering apparatus sputters a substance constituting the

target and adheres the substance onto a surface of a substrate by colliding a high-energy ion against a sputtering surface of a target consisting of the same substance as the film. The sputtering apparatus can provide various advantages, such as that it enables film formation with high-density and high-purity, as compared with the conventional vapor deposition.

Because such a sputtering apparatus sputters by applying a high voltage to a target, it has a risk that a target may be damaged due to heat stress caused by overheating. For this reason, it is common that a target is cooled with cooling water as mentioned in S59-170269, etc., for example.

#### Problem to be solved

A conventional sputtering apparatus, however, was not necessarily able to acquire the excellent cooling effect because a target was indirectly cooled by attaching a target on a packing plate and cooling the packing plate.

#### Means to solve the problem

The present invention has been made in order to solve the above-mentioned problem. The summary of the invention is that a target is cooled by contacting cooling fluid directly to an opposite side of the sputtering surface of the target in said sputtering apparatus.

#### Operation and Effects of the invention

According to the present invention, because a target is directly cooled by certain cooling fluid, such as cooling water or cooling air, the outstanding cooling effect is acquired. Therefore, it enables to apply a higher voltage, and high-speed sputtering can be performed.

#### Embodiment

An embodiment of the present invention is explained in detail below. Fig.1 shows a schematic view of the sputtering apparatus of the present invention. In the drawing, reference numeral 10 shows a bell jar, which is detachably fixed on the base plate 12 to form a sputtering chamber 14. Base plate 12 has a vacuum port 16 and a gas introducing port 18. The vacuum port 16 is connected to a vacuum pump 22 through valve 20, and the gas introducing port 18 is connected to a sputtering gas supply device 26 through valve 24. The sputtering chamber 14 is evacuated by the vacuum pump 22, and kept at a certain gas pressure, e.g.,  $10^{-2}$  to  $10^{-1}$  Torr, by sputtering gas such as argon, etc., which is supplied from the sputtering gas supply device 26.

In the sputtering chamber 14, there is a substrate holder 30 to hold substrates 28,

1 on the surface of which a film is formed. A target 34, which is attached to the target  
2 holding device 32, faces the substrate holder 30 with a certain distance. Target 34 is made  
3 of a material for the film formed on the substrate 28, which is formed into a disk shape with  
4 fine texture after melting a material same as that of the film to be sputtered. As shown in  
5 Figs. 2 and 3, the lower surface of the target is soldered with solder material, such as  
6 gallium and indium, to an annular projection 38 of the fixing member 36, through which  
7 target 34 is attached to the target holding device 32.

8 The target holding device 32 has a holding plate 42 of a disk-shape, through which  
9 a through hole 40 is formed in the center, and a cylinder which is fixed to the through hole  
10 40. The fixing member 36 is fixed to the holding plate by bolts. A pipe 48 runs through  
11 the cylinder 44, and the upper end of the pipe 48 faces the lower surface of target 34. As  
12 shown in Fig. 1, cooling water is supplied from a cooling water circulating device 52, and  
13 the cooling water flowing out of the upper opening of pipe 48 is filled in the space 54  
14 between the target 34 and the holding member, then flowing down between the pipe 48 and  
15 the through hole 50 returning to the cooling water circulating device 52 through the vacuum  
16 port 56. Target 34 is formed with fine texture, and the cooling water does not leak out into  
17 the sputtering chamber 14 through the target 34. An O ring 58 seals between the holding  
18 plate 42 and fixing member 36 to prevent the cooling water from leaking out.

19 The electrical source 60 supplies high voltage making the substrate holder 30 as an  
20 anode and the target 34 as a cathode. Glow discharge is induced by the sputtering gas  
21 between them and high energy plus ions collide against sputtering surface 62 of the target  
22 34 causing the target material sputter from the sputtering surface to attach to the surface of  
23 the substrate 28 forming a film. The shield cylinder 64, 66 around the periphery of the  
24 target holding device 32 and the target 34 protects these.

25 The target 34 is cooled by cooling water supplied by the cooling water circulating  
26 device 52 so that the target 34 is not damaged by the thermal stress despite that high  
27 voltage is imposed and kept in vacuum. Especially, the lower surface of the target 34,  
28 opposite surface of the sputtering surface 62 is directly contact with cooling water  
29 according to this embodiment, and the target 34 is efficiently cooled. Therefore, high  
30 speed sputtering with high voltage is possible.

31 Also, because the target 34 is soldered to the fixing member 36 only at the  
32 periphery, compared with those soldered to the backing plate on the whole lower surface,  
33 there is less diffusion of the solder material into the target 34 resulting in less contamination

1 to target 34, which is generally made of a highly pure material, and also resulting in  
2 improved purity of the formed film.

3 Other embodiments of the present invention are explained below. In the  
4 following embodiments, the same reference numerals are given to the elements, which  
5 work substantially the same as those of the above-mentioned embodiment, and detailed  
6 explanation is omitted.

7 First, Fig. 4 shows a target holding device 68 used for the so-called magnetron  
8 type sputtering apparatus. The target holding device 68 includes a cylinder member with a  
9 bottom 72 having a magnetic field generating device 70 built inside, and pipes 74 and 76  
10 having each upper end inserted from the bottom of the cylinder member 72 into the cylinder.  
11 A magnetic field generating device 70 consists of a disk-shaped yoke 78, a central magnet  
12 80, which is fixed on the center of the upper surface of the yoke 78, and an annular magnet  
13 82, which is fixed on the periphery of the upper surface of the yoke 78. The device  
14 generates a magnetic field having tubular magnetic field lines on the sputtering surface 62  
15 of a target 34 installed on its upper part. The magnetic field lines and the electric field  
16 lines, which is formed perpendicular to sputtering surface 62, create an orthogonal  
17 electromagnetic field adjacent to the sputtering surface 62. The upper ends of said pipes  
18 74 and 76 are fixed to yoke 78 and are open to an annular space 84 between the central  
19 magnet 80 and the annular magnet 82. The cooling water is supplied from the pipe 74  
20 circulating the annular space 84 and discharged from the pipe 76. In this way, the cooling  
21 water directly contacts on the lower surface of the target 34, and cools the target 34, which  
22 is soldered to an annular fixing member 86 in the periphery of the lower surface and is  
23 attached to the cylinder member with a bottom 72 through the fixing member 86.

24 Fig. 5 shows the embodiment having an annular protrusion 88 in the periphery of  
25 said holding plate 42, and a target 34 is directly attached to the tip of the annular protrusion  
26 88 with bolts 90. The cooling water supplied from a pipe 48 circulates in the space 92  
27 between the holding plate 42 and the target 34, and the target is directly cooled by the  
28 cooling water.

29 The embodiment in Fig. 6 installs a target 34, which is fixed on a packing plate 94,  
30 to a target holding device. The upper surface of the packing plate 94, that is, the side  
31 where the target 34 is fixed on, has multiple circular grooves 96 concentrically, and the  
32 cooling water circulates in the circular grooves 96 and directly cools the target 34.

33 As described above, some embodiments of the present invention have been

1 explained in detail referring to the drawings. These embodiments are mere examples.  
2 For instance, instead of the cooling water, other cooling fluid, such as cooling air, may be  
3 used, and a rectangular plate target or a cylinder shaped target may be used as a target.  
4 Based on the knowledge of a person skilled in the art, various modification and  
5 improvements can be made when carrying out the present invention.  
6

#### 7 4. Brief Description of Drawings

8 Fig. 1 is a schematic view of the sputtering apparatus of an embodiment of the  
9 present invention. Fig. 2 is a top view of the sputtering apparatus of Fig. 1 having the  
10 target attached to the target holding device with a part of the surface removed. Fig. 3 is a  
11 longitudinal sectional view of Fig. 2. Fig. 4 is shows a relevant part of another  
12 embodiment of the present invention, a longitudinal sectional view of a target holding  
13 device with a target installed. Fig. 5 shows a relevant part of another embodiment of the  
14 present invention, corresponding to Fig. 4. Fig. 6 shows a relevant part of another  
15 embodiment of the present invention, a longitudinal sectional view of a target fixed on a  
16 packing plate.  
17

18 34: Target      62: Sputtering Surface  
19